

radium compound are derived from several distinct atoms, the parent radium atom, and the successive products of its disintegration, it is to be expected, as Rutherford has pointed out, that the velocity of the α particles will vary within certain limits. Becquerel, however, states that the α radium rays in his experiments were deflected as a homogeneous pencil. Moreover, according to the same authority, they possess the remarkable property of being the more difficult to deviate for any given strength of field the greater the distance of air traversed. Both these observations seem contrary to what we should expect, and the latter especially is difficult to account for.

With regard to the "spintariscopes" effect of the α ray when it impinges on a zinc-blende screen, discovered by Crookes, it appears probable from the work of Becquerel, Tommasina and others that the scintillations are not caused, as was at first thought, by the direct impact of the individual α particle, but are due to cleavages provoked in the crystals of the blende by the bombardment, each cleavage, rather than each impact, giving rise to a flash of light.

The spontaneous heat evolution of radium to the extent of 100 gram-calories per gram of radium per hour, which was established some months ago by Curie and Laborde by direct calorimetric experiments, although it is the fact about radium which has appealed most strongly to the general imagination, hardly came as a surprise to those who were aware of the other properties of the element. Rutherford and McClung in 1901 estimated the energy radiated from a gram of uranium oxide as at least 0.03 calorie per gram per year, and it was known that this must be increased at least a million times for the case of radium. In addition, the well known chemical actions of the radium rays—the conversion of oxygen into ozone, and the decomposition of water into its elements—showed that their energy must be very considerable. The recent discovery of Rutherford and Barnes that more than 70 per cent. of the energy evolved from radium is due to the insignificant amount of emanation and the products of its further change, less than 30 per cent. being due to the element itself, follows as a direct consequence of the disintegration theory. It furnishes, it would seem, an almost unanswerable argument against the view that the energy evolved from radium is derived from an external source of unknown nature.

The view that radio-activity proceeds independently of temperature, which was originally arrived at by Becquerel by his study of the radiations of uranium, and is now generally recognised, was confirmed by M. Curie last year by some careful measurements of the rate of decay of the penetrating radiation from a sealed glass tube containing the radium emanation. He showed that the rate of the decay was not affected by variations of temperature between 450° C. and -180° C. Since it is the universal experience, not only for variations in temperature, but also for all other agents, that the rate of disintegration is constant and unaffected by molecular forces, it follows that the causes at work which produce disintegration are at present entirely unknown. It appears certain that it cannot be brought about by any agencies with which we are familiar. Sir Oliver Lodge has suggested that the unstable condition results from the incessant radiation of the internal energy of the atom, the latter being a necessary consequence of the electronic theory of atomic structure.

The discovery by Sir William Ramsay and the writer that radium is continuously producing helium in sufficient quantities to be spectroscopically recognised marks a new phase in the development of radio-activity by bringing the problem within the range of

the ordinary methods of chemical investigation. From the disintegration theory it followed that the accumulation, during past ages, of the final products of the change of the radio-elements must exist in the natural minerals in which these elements are found. The existence of helium in the radio-active minerals, and its absence from those which do not contain the radio-elements, coupled with the fact that this gas forms no compounds but exists in the minerals "occluded" in a curious and unexplained way, pointed strongly to the view that it had been formed as one of the products of the change of one of the radio-elements during past ages, and mechanically imprisoned within the mineral. This led to the experiments being undertaken. The gradual growth of the helium spectrum in a sealed tube in which the radium emanation was originally condensed by liquid air and all other gases removed by the pump, excludes the view that radium may form a slowly decomposing compound with helium. The amount produced, as theory requires, is excessively minute, and its detection with the small quantity of radium available was due to the extreme delicacy of its spectrum reaction, and to the refined methods of gas manipulation developed by Ramsay in his investigation of the rare gases of the atmosphere. The suggestion that has been made that the α particle is an atom of helium has not yet been experimentally proved.

These direct confirmations of the theoretical predictions show that our knowledge of radio-activity has passed from a purely descriptive basis. The numerous unrelated and inexplicable experimental facts which have accumulated during the seven years the property has been known have during the past year been co-ordinated harmoniously as the effect of a definite and consistent cause. Radio-activity, in consequence, claims to-day to rank as an independent science. It is a property which may be best described as added on. It manifests itself without affecting or being affected by the ordinary chemical and physical nature of the matter in question, and therefore belongs to the domain neither of physics nor of chemistry. There is in consequence reason for considerable satisfaction that the theory of atomic disintegration to which radio-activity has directly led is also in the nature of an addition to, rather than a controversion of, accepted scientific doctrines. Nothing could be further from the truth than the idea that it upsets in any way the atomic theory of chemistry. On the contrary, as the bearing of the conception comes to be more clearly seen, it will probably be recognised that it provides the atomic theory with a measure of confirmation and new evidence which advances it a little further in the direction of that direct experimental proof which we are so frequently being reminded it is impossible for any theory to attain.

FREDERICK SODDY.

OBSERVATIONS OF GLACIERS AND AVALANCHES.¹

BOTH the pamphlets mentioned below are issued by the Commission Française des Glaciers. The former mainly consists of a study of the glaciers about the head-waters of the Arc, a region which, forty years ago, had been visited only by a few Alpine climbers, who found the official maps far from accurate above the snow line; following this are notes about glaciers of the Grandes Rousses, a snowy ridge

¹ "Rapport sur les Observations Glaciaires en Haute-Maurienne, dans les Grandes-Rousses et l'Oisans, dans l'été de 1902." Par M. Paul Girardin. Revue de Glaciologie. No. 2. Année 1902. Par M. Charles Rabot. Pp. 121; illustrated. (Paris: Typographie Philippe Renouard, 1903.)

² "Observations sur l'Enneigement et sur les Chutes d'Avalanches, exécutées par l'Administration des Forêts dans les Départements de la Savoie. Pp. 15. (Paris: Au siège du Club Alpin Français, 1903.)

between the Maurienne and Dauphiné. In the former region the glaciers are not large, though fairly continuous along the western side of the watershed between France and Italy; the highest peaks just exceeding 12,000 feet, and the passes between them being about 10,000 feet. M. Girardin in his remarks directs attention to a point not always sufficiently remembered, that the size of a glacier depends even more upon the form of its birthplace than the altitude. Of this, Dauphiné, rather to the south of the region noticed by him, affords an excellent example. The western end of the horseshoe of its higher peaks is formed by the Mont de Lans, a tabular mountain mass, which, though mostly well under 11,000 feet high, is clothed with a sheet of névé, terminating in glaciers, more extensive than those of the adjoining Râteau and Meije, which rise some 2000 feet higher. It is incidentally mentioned, and this fact is important, that the climate of Lanslebourg is much wetter than that of Modane, the dominant wind at the latter being W. or N.W., at the former E. or S.E., bringing vapour from the plain of the Po. As the district is so little known, we content ourselves with giving M. Girardin's general conclusions. They are:—(1) the glaciers of this region, after a rapid retreat (since 1860 approximately), have during the last few years either moved back very slowly or even halted; (2) this retreat has changed many of them from valley glaciers to plateau glaciers; (3) sometimes the glacier has gone back as a whole, sometimes it has melted away from the sunny side of a valley, thus changing the form of its terminal boundary, a matter to be remembered in speaking of the "retreat" of a glacier.

This report is followed by the *Revue de Glaciologie*, No. 2, giving a summary of observations about the increase or decrease of glaciers in many parts of the world, made or published in 1902, with occasional mention of earlier changes, and some interesting notes on the level of the snow-line. Evidently, though locally the retreat has been arrested or even changed into an advance, a period of growth has not yet really begun.

The second pamphlet largely consists of tables giving the snowfall and avalanches in parts of the French Alps during the winter of 1899-1900 and the two following years. These will ultimately be very valuable, but at present hardly suffice for drawing inferences. We may, however, mention that in the first period the snowfall in Savoy ranged from 85 mm. at Thonon to 1600 mm. at Sixt. The largest amount recorded is on the Col de Fréjus, in the Maurienne (almost above the great tunnel), the differences probably depending mostly on altitude but to some extent on geographical position. In that year the largest downfall in an hour was 68.6 mm., on this pass and its neighbourhood. The statistics of avalanches are for 1900-1, and for the following season. March is the worst month, then February and April. The falls were much more numerous and mischievous in the second year, during which fifty-six persons were overwhelmed by them, of whom eight perished, as against three in the former year.

JOHN SAMUEL BUDGETT.

BRITISH zoology in general, and the Cambridge School of Zoology in particular, has received a heavy blow in the tragic and untimely death of Mr. J. S. Budgett. It is only a few weeks since the readers of NATURE were informed of the brilliant success attending Mr. Budgett's researches during his last expedition, and zoologists—not of this country alone—were looking forward with the greatest interest to the publication of his full results. It was not to be. On

Saturday, January 9, after his usual day's work in the laboratory at Cambridge, he fell ill with blackwater fever, and after a few days' illness he passed away on the morning of January 19, the very day on which he was to have read to the Zoological Society his account of the general results of his last expedition.

Mr. Budgett was born near Bristol thirty-one years ago, and here, at his home, Stoke Bishop, the earlier years of his life were passed. In his father's house Budgett had the great advantage of meeting as friends such men as Dr. W. H. Dallinger and the late Prof. W. K. Parker, and from them he received much inspiration and encouragement. He was particularly influenced by Parker. He possessed copies of Parker's monographs, and he set himself a task which few indeed would have attempted without an elaborate university training, the task of working over the development of the skull in a series of vertebrate types. By the exercise of limitless patience and admirable technical skill—he even designed a perfectly original and remarkably successful mechanical microtome for the cutting of serial sections—he produced a series of beautiful models of developing crania.

Mr. Budgett commenced his academic studies at University College, Bristol, under Lloyd Morgan and Reynolds, and thence passed on to Cambridge and entered Trinity College in 1894. There he went through the routine course of study for the natural sciences tripos—interfered with to some extent, from the point of view of mere academic success, by his accompanying Prof. Graham Kerr on an expedition to South America during 1896-7. On this expedition Budgett devoted himself to gaining a general acquaintance with the neotropical fauna, and also to broadening his knowledge of general morphology by carrying out dissections and making microscopic preparations of many of the more important animals. In addition to this he applied himself especially to the study of the Amphibia, amassing a large amount of information as well as valuable collections of developmental and other material. This material received preliminary treatment in a paper in the *Quarterly Journal of Microscopical Science*, but Budgett intended to work it up later in a comparative paper along with the material collected under similar physical conditions in West Africa.

On this first expedition Budgett's splendid qualities shone out conspicuously—his personal courage, his fortitude and cheerfulness under physical discomfort and suffering, and his absolute loyalty.

Already during his stay in South America Budgett had practically decided to take up the problem of the development of Polypterus, and immediately after graduating at Cambridge he set out with this object in view to the Gambia. Here he spent the greater part of a year in the first instance, returning again for a few months during 1900. During these expeditions Mr. Budgett did not manage to obtain the main object of his quest, but he did succeed in obtaining and preserving with the faultless technique so characteristic of him a mass of most valuable material. The hand of Death has intervened before time had been given for more than preliminary work on this material, but even this preliminary work contains results of much importance to vertebrate zoology—in particular a complete and accurate account of the genito-urinary organs of Polypterus, the demonstration that the crossopterygian fin is really a uniserial archipterygium, and finally a most valuable series of observations on the breeding habits and developmental features of Protopterus and of several interesting teleostean fishes.

Budgett still stuck pertinaciously to the main problem. Having been elected Balfour student, he